IN THE UNITED STATES PATENT & TRADEMARK OFFICE

PATENT APPLICATION: Serial No. UNKNOWN	GROUP ART UNIT: UNKNOWN
	EXAMINER: Unknown
ORIGINALLY FILED: October 20, 1998	DOCKET NUMBER: 9086-104D
FOR: OVERSCAN HELICAL SCAN HEAD FOR NON-TRACKING TAPE SUBSYSTEMS READING AT UP TO 1X SPEED AND METHODS FOR SIMULATION OF SAME	
INVENTORS: Blatchley et al.	

PRELIMINARY AMENDMENT

The Honorable Commissioner of
 Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to examining the above named application, please amend the application as follows and consider the following remarks:

AMENDMENTS

In the Specification:

Please amend the specification after the title by inserting the following heading:

--Cross Reference to Related Applications--;

and add the paragraph:

--This is a divisional of copending application serial number 09/176,013 filed on October 20, 1998.--.

Please rewrite the paragraph beginning at page 1, line 13 as follows:

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The present invention is related to co-pending U.S. patent application entitled "Variable Speed Recording Method and Apparatus for a Magnetic Tape Drive", invented by Beavers et al., and having an internal docket number of 9086/101 and a serial number of 09/176,079, filed concurrently herewith on October 20, 1998, and co-pending U.S. patent application entitled "Fine Granularity Rewrite Method and Apparatus for Data Storage Device", invented by Zaczek, and having an internal docket number of 9086/106 and a serial number of 09/176,015, filed concurrently herewith on October 20, 1998, and co-pending U.S. patent application entitled "Multi-level Error Detection and Correction Technique for Data Storage Recording Device", invented by McAuliffe et al., and having an internal docket number of 9086/102 and a serial number of 09/176,014, filed concurrently herewith on October 20, 1998, all of which are commonly owned and all of which are hereby incorporated by reference.

Please rewrite the paragraph beginning on page 2, line 13 as follows:

As physical limits were encountered in design of such linear tape devices, helical scan tape subsystems evolved to further increase tape medium storage densities. This is a recording format in which a relatively slow moving tape is helically wrapped around a rapidly rotating drum with an embedded record head and read head. The tape is positioned at a slight angle to the equatorial plane of the drum. This results in a recording format in which recorded tracks run diagonally across the tape from one edge to the other. The record head rotates past the tape spanning a diagonal from one edge to the other. As the drum rotates, the record head records another diagonal track with more data. Recorded tracks are parallel to each other but are each at an angle to the edge of the tape. This geometry of discrete sized tracks on the magnetic tape medium allows still higher densities of data to be stored on the tape as compared to older linear (longitudinal) tape subsystems.

Please rewrite the paragraph beginning on page 4, line 1 as follows:

As noted, tracking circuits add significant complexity and associated cost to helical scan tape devices. Some helical scan devices are non-tracking in that they use no such expensive tracking circuits to assure alignment of the heads with the track. Rather, presently known non-tracking tape devices significantly slow the tape speed relative to the drum to permit multiple passes of the read head over the same track. Each pass is at a slightly different longitudinal position on the tape due to the tape movement but because of the slower speed overlaps a portion of the track read by the previous pass. This overlap of sequential passes is often referred to as overscan. To achieve sufficient overscan to assure proper reading of the track by at least one of the read heads, such non-tracking devices reduce the speed of the tape to half of the nominal speed (i.e., half the speed at which the tracks were recorded). This permits a first pass read to overlap a second pass read thereby helping to assure that one of the passes will substantially cover the track width. However, slowing the tape for read operations negatively impacts read operation performance of the tape device.

Please rewrite the paragraph beginning on page 5, line 6 as follows:

Each pair of like-azimuth (like type) heads is separated vertically on the surface of the drum so that each read head passes over a given track with a longitudinal offset relative to one another at nominal tape speed (i.e., at the tape speed used for writing). The width of each head (also referred to herein as head width or gap width) is also selected so as to create an overlap between the two scans of the track by the corresponding two like-azimuth read heads.

Please rewrite the paragraph beginning on page 6, line 32 and continuing through page 7, line 10 as follows:

In a second aspect of the invention, a helical scan drum is provided for use in non-tracking tape storage subsystem. The drum has a first and second

read head on its circumference. The second read head is positioned on the drum such that it overscans a track following the first read head within a single rotation of the drum. Also, the second read head is positioned on the drum such that the area read by at least one of the two read heads covers the area of the track by at least a predetermined coverage threshold value. In certain circumstances such as misaligned tracks on the tape medium, the heads on the rotating drum may read portions of a single track over multiple rotations. Further, if tape speed is slowed by the tape controller, such as when a host computer cannot accept data at full speed, portions on a single track may be scanned multiple times over multiple rotations. Similarly at slower tape speeds each drum rotation may cause the heads to scan portions of multiple tracks. In all cases, the heads are positioned on the drum to assure at least 100% scan coverage of the entire recording area of the tape medium by the multiple heads on the rotating drum.

Please rewrite the paragraph beginning on page 8, line 21 as follows:

As is known in the art of helical scan tape devices, drum 85 is positioned within the tape device such that tape medium 80 typically wraps around between 90 and 180 degrees of the circumference of drum 85. Further, the drum 85 is positioned at an angle relative to the tape medium 80 such that tracks are written at an angle on the tape medium 80 extending from one edge to the other.

Please rewrite the paragraph beginning on page 12, line 5 as follows:

Element 404 is next operable to simulate the reading of a track using the present parameter set. As discussed further herein below, the read of a simulated track by a simulated head is performed by calculating the geometric area covered by the track and the head (each essentially a rectangular area). The geometric area covered by the track and by the head is essentially its present physical position relative to the rotating drum. This is computed from

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the provided parameters including the tape speed parameter. The geometric area scanned by the read head is essentially the rectangular area swept by the read head as it rotates on the simulated drum over the present physical location of the track. The overlap between the two rectangular geometric areas, the track area and the head scan area for all heads, determines the success or failure of the read operation as noted below. Element 404 is operable to compute the geometric areas of the track and the head in accordance with the present parameter set.

Please rewrite the paragraph beginning on page 13, line 7 as follows:

As noted herein, each head may provide adequate coverage for portions of a track and not for other portions of a track. Further, each head may cover portions of a track on one rotation and other portions of that track on a subsequent rotation. The combined geometric area, as used herein, therefore means the union of all coverage by all heads over all portions of the tracks. In other words, for each portion of a track, so long as any of the heads of identical azimuth for that track adequately covers that portion, that portion is deemed to be covered by the combined geometric area of the scanning of all heads. If a sufficient percentage of portions of a track are so adequately covered by the combined geometric area of the scanning heads, then the track is adequately covered by the combined geometric area of the scanning heads.

Please rewrite the paragraph beginning on page 13, line 23 as follows:

Element 416 is then operable to determine if more head gap settings remain to be processed as specified by the user supplied parameters. If so, element 418 is operable to increment the IGAP index variable and processing continues by looping back to element 404. If not, processing continues with element 420 to reset the IGAP index variable to zero in preparation for another parameter setting.

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In the Claims:

Please cancel original claims 12-17.

Please amend the remaining claims as follows:

1. (Amended) A method for evaluating parameters of a drum design for use in a helical scan tape device comprising the steps of:

(a) receiving said parameters wherein said parameters include position of a first read head on said drum, said first read head sensing data recorded along a first azimuth;

(b) simulating the reading of one track of a plurality of tracks by calculating the geometric area said first read head would cover as it scans over said track of predetermined dimensions;

(c) determining the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track;

(d) determining that the simulated read is successful when said percentage is greater than a predetermined coverage threshold value;

(e) repeating steps (b) through (d) for each of said plurality of tracks; and

(f) determining that said parameters are effective for a drum design when a number of said plurality of tracks for which the simulated read was determined to be successful is greater than a predetermined error rate threshold value.

2. (Amended) The method of claim 1 wherein said parameters includes position of a second read head on said drum, and

wherein the step of simulating further comprises the step of simulating the reading of said track by calculating the combined geometric area that would be covered by said first read head and by said second read head as they scan over said track, said first read head sensing data recorded along a first

azimuth; and

wherein the step of determining the amount of overlap comprises the step of determining the amount of overlap of said combined geometric area as a percentage of area defined by said predetermined dimensions of said track.

8.   (Amended) A method for evaluating parameters of a drum design for use in a helical scan tape device comprising the steps of:

(a) receiving said parameters wherein said parameters include a position of a first read head on said drum and a position of a second read head on said drum, said first read head sensing data recorded along a first azimuth and said second read head sensing data recorded along said first azimuth;

(b) simulating the reading of one track of a plurality of tracks by calculating a first geometric area said first read head would cover as it scans over said track of predetermined dimensions and by calculating a second geometric area said second read head would cover as it scans over said track;

(c) determining the amount of overlap of said first geometric area as a first percentage of the area defined by said predetermined dimensions of said track and the amount of overlap of said second geometric area as a second percentage of the area defined by said predetermined dimensions of said track;

(d) determining that the simulated read is successful when either said first percentage is greater than a predetermined coverage threshold value or said second percentage is greater than said predetermined coverage threshold value;

(e) repeating steps (b) through (d) for each of said plurality of tracks; and

(f) determining that said parameters are effective for a drum design when a number of said plurality of tracks for which the simulated read was determined to be successful is greater than a predetermined error rate threshold value.

Please add the following new claims 12 -18:

12. A drum evaluation simulator which evaluates parameters of a drum design for use in a helical scan tape device comprising:

a parameter receiving element for receiving said parameters wherein said parameters include position of a first read head on said drum;

a read simulation element for simulating the reading of one track of a plurality of tracks by calculating the geometric area said first read head would cover as it scans over said track of predetermined dimensions; and

a coverage determination element for determining the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track.

13. The drum evaluation simulator of claim 1 wherein said parameters includes position of a second read head on said drum, and

wherein the read simulation element simulates the reading of said track by calculating the combined geometric area that would be covered by said first read head and by said second read head as they scan over said track, and

wherein the coverage determination element determines the amount of overlap of said combined geometric area as a percentage of area defined by said predetermined dimensions of said track.

14. The drum evaluation simulator of claim 1 wherein said parameters includes positions of a plurality of read heads on said drum, and

wherein the read simulation element simulates the reading of said track by calculating the combined geometric area that would be covered by said plurality of read heads as they scan over said track, and

wherein the coverage determination element determines the amount of overlap of said combined geometric area as a percentage of area defined by said predetermined dimensions of said track.

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15.   The drum evaluation simulator of claim 1 wherein said parameters include a nominal tape speed and wherein:

the read simulation element varies said tape speed from said nominal tape speed parameter value to generate an alternate tape speed value; and

the coverage determination element determines the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track for said alternate tape speed value.

16.   The drum evaluation simulator of claim 4 wherein said read simulation element generates said alternate tape speed values as values less than or equal to the nominal speed of said tape device.

17.   The drum evaluation simulator of claim 1 wherein said parameters include a nominal gap width and wherein:

the read simulation element varies said gap width from said nominal gap width parameter value to generate an alternate gap width value; and

the coverage determination element determines the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track for said alternate gap width value.

18.   The drum evaluation simulator of claim 1 wherein said parameters include a nominal head offset spacing and wherein:

the read simulation element varies said head offset spacing from said nominal head offset spacing parameter value to generate an alternate head offset spacing value; and

the coverage determination element determines the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track for said alternate head offset spacing value.

REMARKS

1. Remarks Regarding Amendments to Claims

Claims 1-18 are pending in the application. Claims 1, 2, and 8 have been amended; claims 12-17 in the prior application have been canceled and new claims 12-18 have been added in their place; and claims 3-7 and 9-11 remain in the application unchanged. No new matter has been added.

Applicant's Invention

The present invention is directed at a method and simulator for optimally designing the placement of like-azimuth heads on a helical scan drum for reading data in non-tracking tape subsystem.

The invention determines optimal placement of pairs of like-azimuth heads to achieve accurate reading of helical scan tracks without resorting to complex, costly tracking circuits and without unduly slowing the performance of the tape device for read operations. The invention determines the vertical separation of each pair of like-azimuth (like type) heads on the surface of the drum so that each read head passes over the same track with a longitudinal offset relative to one another at nominal tape speed (i.e., at the tape speed used for writing). The invention also selects the width of each head (also referred to herein as head width or gap width) so as to create an overlap between the two scans of the track by the corresponding two like-azimuth read heads such that The two heads for each azimuth type overlap one another to a degree that their combined area (their effective coverage) of scan is greater than approximately 100% of the track pair width (the sum of the widths of adjacent A and B tracks). The invention selects head dimensions to assure adequate coverage at a broad range of tape speeds up to the write operation nominal speed (referred to herein as 1X speed) as well as lower speeds.
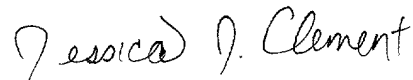
The Applicant's submits that none of the prior art of record teaches the novel limitations of claims 1-18.

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CONCLUSION

In view of the foregoing remarks, it is respectfully submitted that none of the references cited by the Examiner taken either alone or in combination shows, teaches, or makes obvious the novel structures of Claims 1-18 inclusive, and that Claims 1-18 are in condition for allowance. Reexamination and reconsideration are requested.

Should the Examiner have any questions regarding this amendment, or should the Examiner believe that it would further prosecution of this application, the Examiner is invited to call the undersigned directly at (856) 854-3999.

Respectfully submitted,

March 20, 2001

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Annotated Version of Amendments

In the Specification:

After the title, new heading and paragraph have been inserted as follows:

--Cross Reference to Related Applications--

--This is a divisional of copending application serial number 09/176,013 filed on October 20, 1998.--

Paragraph beginning at page 1, line 13 has been amended as follows:

The present invention is related to co-pending U.S. patent application entitled "Variable Speed Recording Method and Apparatus for a Magnetic Tape Drive", invented by Beavers et al., and having an internal docket number of 9086/101 and a serial number of 09/176,079, filed concurrently herewith on October 20, 1998, and co-pending U.S. patent application entitled "Fine Granularity Rewrite Method and Apparatus for Data Storage Device", invented by Zaczek, and having an internal docket number of 9086/106 and a serial number of 09/176,015, filed concurrently herewith on October 20, 1998, and co-pending U.S. patent application entitled "Multi-level Error Detection and Correction Technique for Data Storage Recording Device", invented by McAuliffe et al., and having an internal docket number of 9086/102 and a serial number of 09/176,014, filed concurrently herewith on October 20, 1998, all of which are commonly owned and all of which are hereby incorporated by reference.

Paragraph beginning on page 2, line 13 has been amended as follows:

As physical limits were encountered in design of such linear tape devices, helical scan tape subsystems evolved to further increase tape medium storage densities. This is a recording format in which a relatively slow moving tape is helically wrapped [180°] around a rapidly rotating drum with an embedded record head and read head. The tape is positioned at a slight angle to the equatorial plane of the drum. This results in a recording format in which

recorded tracks run diagonally across the tape from one edge to the other. The record head rotates past the tape spanning a diagonal from one edge to the other. As the drum rotates, the record head records another diagonal track with more data. Recorded tracks are parallel to each other but are each at an angle to the edge of the tape. This geometry of discrete sized tracks on the magnetic tape medium allows still higher densities of data to be stored on the tape as compared to older linear (longitudinal) tape subsystems.

Paragraph beginning on page 4, line 1 has been amended as follows:

As noted, tracking circuits add significant complexity and associated cost to helical scan tape devices. Some helical scan devices are non-tracking in that they use no such expensive tracking circuits to assure alignment of the heads with the track. Rather, presently known non-tracking tape devices significantly slow the tape speed relative to the drum to permit multiple passes of the read head over the same [tack] track. Each pass is at a slightly different longitudinal position on the tape due to the tape movement but because of the slower speed overlaps a portion of the track read by the previous pass. This overlap of sequential passes is often referred to as overscan. To achieve sufficient overscan to assure proper reading of the track by at least one of the read heads, such non-tracking devices reduce the speed of the tape to half of the nominal speed (i.e., half the speed at which the tracks were recorded). This permits a first pass read to overlap a second pass read thereby helping to assure that one of the passes will substantially cover the track width. However, slowing the tape for read operations negatively impacts read operation performance of the tape device.

Paragraph beginning on page 5, line 6 has been amended as follows:

Each pair of like-azimuth (like type) heads is separated vertically on the surface of the drum so that each read head passes over [the same] a given track with a longitudinal offset relative to one another at nominal tape speed

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(i.e., at the tape speed used for writing). The width of each head (also referred to herein as head width or gap width) is also selected so as to create an overlap between the two scans of the track by the corresponding two like-azimuth read heads.

Paragraph beginning on page 6, line 32 and continuing through page 7, line 10 has been amended as follows:

In a second aspect of the invention, a helical scan drum is provided for use in non-tracking tape storage subsystem. The drum has a first and second read head on its circumference. The second read head is positioned on the drum such that it overscans a track following the first read head within a single rotation of the drum. Also, the second read head is positioned on the drum such that the area read by at least one of the two read heads covers the area of the track by at least a predetermined coverage threshold value. In certain circumstances such as misaligned tracks on the tape medium, the heads on the rotating drum may read portions of a single track over multiple rotations. Further, if tape speed is slowed by the tape controller, such as when a host computer cannot accept data at full speed, portions on a single track may be scanned multiple times over multiple rotations. Similarly at slower tape speeds each drum rotation may cause the heads to scan portions of multiple tracks. In all cases, the heads are positioned on the drum to assure at least 100% scan coverage of the entire recording area of the tape medium by the multiple heads on the rotating drum.

Paragraph beginning on page 8, line 21 has been amended as follows:

As is known in the art of helical scan tape devices, drum 85 is positioned within the tape device such that tape medium 80 typically wraps around [substantially] between 90 and 180 degrees of the circumference of drum 85. Further, the drum 85 is positioned at an angle relative to the tape medium 80 such that tracks are written at an angle on the tape medium 80 extending from

one edge to the other.

Paragraph beginning on page 12, line 5 has been amended as follows:

Element 404 is next operable to simulate the reading of a track using the present parameter set. As discussed further herein below, the read of a simulated track by a simulated head is performed by calculating the geometric area covered by the track and the head (each essentially a rectangular area). The geometric area covered by the track and by the head is essentially its present physical position relative to the rotating drum. This is computed from the provided parameters including the tape speed parameter. The geometric area scanned by the read head is essentially the rectangular area swept by the read head as it rotates on the simulated drum over the present physical location of the track. The overlap between the two rectangular geometric areas, the track area and the head scan area for all heads, determines the success or failure of the read operation as noted below. Element 404 is operable to compute the geometric areas of the track and the head in accordance with the present parameter set.

Paragraph beginning on page 13, line 7 has been amended as follows:

As noted herein, each head may provide adequate coverage for portions of a track and not for other portions of a track. Further, each head may cover portions of a track on one rotation and other portions of that track on a subsequent rotation. The combined geometric area, as used herein, therefore means the union of all coverage by all heads over all portions of the tracks. In other words, for each portion of a track, so long as any of the heads of identical azimuth for that track adequately covers that portion, that portion is deemed to be covered by the combined geometric area of the scanning of all heads. If a sufficient percentage of portions of a track are so adequately covered by the combined geometric area of the scanning heads, then the track is adequately covered by the combined geometric area of the scanning heads.

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Paragraph beginning on page 13, line 23 has been amended as follows:

Element 416 is then operable to determine if more head gap [setting] settings remain to be processed as specified by the user supplied parameters. If so, element 418 is operable to increment the IGAP index variable and processing continues by looping back to element 404. If not, processing continues with element 420 to reset the IGAP index variable to zero in preparation for another parameter setting.

In the Claims:

Original claims 12-17 have been canceled.

New claims 12-18 have been added.

Claim 1 has been amended as follows:

1. (Amended) A method for evaluating parameters of a drum design for use in a helical scan tape device comprising the steps of:

(a) receiving said parameters wherein said parameters include position of a first read head on said drum, said first read head sensing data recorded along a first azimuth;

(b) simulating the reading of one track of a plurality of tracks by calculating the geometric area said first read head would cover as it scans over said track of predetermined dimensions;

(c) determining the amount of overlap of said geometric area as a percentage of the area defined by said predetermined dimensions of said track;

(d) determining that the simulated read is successful when said percentage is greater than a predetermined coverage threshold value;

(e) repeating steps (b) through (d) for each of said plurality of tracks; and

(f) determining that said parameters are effective for a drum design when a number of said plurality of tracks for which the simulated read was determined to be successful is greater than a predetermined error rate threshold value.

Claim 2 has been amended as follows:

2.   (Amended) The method of claim 1 wherein said parameters includes position of a second read head on said drum, and

wherein the step of simulating further comprises the step of simulating the reading of said track by calculating the combined geometric area that would be covered by said first read head and by said second read head as they scan over said track, said first read head sensing data recorded along a first azimuth; and

wherein the step of determining the amount of overlap comprises the step of determining the amount of overlap of said combined geometric area as a percentage of area defined by said predetermined dimensions of said track.

Claim 8 has been amended as follows:

8.   (Amended) A method for evaluating parameters of a drum design for use in a helical scan tape device comprising the steps of:

(a) receiving said parameters wherein said parameters include a position of a first read head on said drum and a position of a second read head on said drum, said first read head sensing data recorded along a first azimuth and said second read head sensing data recorded along said first azimuth;

(b) simulating the reading of one track of a plurality of tracks by calculating a first geometric area said first read head would cover as it scans over said track of predetermined dimensions and by calculating a second geometric area said second read head would cover as it scans over said track;

(c) determining the amount of overlap of said first geometric area as a first percentage of the area defined by said predetermined dimensions of said track and the amount of overlap of said second geometric area as a second percentage of the area defined by said predetermined dimensions of said track;

(d) determining that the simulated read is successful when either said first percentage is greater than a predetermined coverage threshold value or

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said second percentage is greater than said predetermined coverage threshold value;

(e) repeating steps (b) through (d) for each of said plurality of tracks; and

(f) determining that said parameters are effective for a drum design when a number of said plurality of tracks for which the simulated read was determined to be successful is greater than a predetermined error rate threshold value.